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Economic Planning Framework for Fishery and Habitat Management in the Northwest Territories and Yukon North Slope

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R3T 2N6

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by

D.E. Topolniski

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This is the 1st Economic and Commercial Analysis Report
from the Central and Arctic Region, Winnipeg

Preface

This report provides resource managers and wildlife management boards with a systematic approach for the economic analysis of the fisheries of the Northwest Territories and Yukon North Slope.

Four general subject areas where economic analysis can support fishery and habitat management decision-making are: sustaining the yield from domestic fisheries; fostering viable commercial fishery development; efficient resource management and; management of fish habitat.

The multi-account planning framework, originally developed for DFO's Salmonid Enhancement Program, is an analytic tool that enables the display and systematic comparison of fishery management options. Five accounts are included in the assessment: economic efficiency, employment, regional development, cultural significance, and resource conservation.

Economic evaluation criteria for the fisheries are: (1) economic efficiency, a net benefit measure of the difference between gross value of output and costs of production and; (2) economic impact, a gross benefit measure of the distribution of income and employment benefits.

Economic indicators and analysis tools are described for the economic efficiency analysis of the domestic, commercial, and recreational fisheries. Economic impact analysis is proposed for assessment of the contribution to employment and regional development. Qualitative indicators are proposed for assessment of the contribution to cultural significance and resource conservation.

The Department of Fisheries and Oceans will co-operate with resource users, management boards, and other agencies in the implementation of the planning framework. Implementation will proceed through the conduct of selected case studies, general economic surveys, and economic services for fishery management plans and fishery development.

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Abstract

TOPOLNISKI, D.E. 1991. Economic planning framework for fishery and habitat management in the Northwest Territories and Yukon North Slope. *Econ. Commer. Anal. Rep.* 85: iv + 28 p.

This report provides resource managers and wildlife management boards with a systematic approach for the economic analysis of the fisheries of the Northwest Territories and Yukon North Slope. Subject areas where economic analysis can support fishery management decisions are: sustaining the yield from domestic fisheries; fostering viable commercial fishery development; efficient resource management and; management of fish habitat. The proposed multi-account planning framework examines the effects of management options on economic efficiency, employment, regional development, cultural significance, and resource conservation. Models and methods are described for economic efficiency and economic impact analysis of domestic, commercial, and recreational fisheries.

Key words: artisanal fishing; fisheries; sport fishing; employment; regional development.

Résumé

TOPOLNISKI, D.E. 1991. Economic planning framework for fishery and habitat management in the Northwest Territories and Yukon North Slope. *Econ. Commer. Anal. Rep.* 85: iv + 28 p.

Le présent rapport décrit à l'intention des gestionnaires des ressources et des conseils de gestion de la faune une approche systématique a l'analyse économique des pêcheries dans le versant nord du Yukon et des Territoires du Nord-Ouest. Les domaines où l'analyse économique peut venir appuyer les décisions en matière de gestion de la pêche sont les suivants: rendement soutenu de la pêche intérieure, développement d'une pêche commerciale viable, gestion efficace des ressources et gestion de l'habitat des poissons. Le cadre de planification à volets multiples proposé permet d'examiner les effets des choix de gestion sur l'efficacité économique, l'emploi, le développement régional, la signification culturelle et la conservation des ressources. On décrit des méthodes et des modèles pour l'analyse de l'efficacité économique et de l'impact économique des pêches intérieure, commerciale et récréative.

Mots-clés: pêche artisanale; pêcheries; pêche sportive; emploi; développement régional.

1 Introduction

The Department of Fisheries and Oceans (DFO) management objectives, strategies, and program guidelines for fisheries and habitat management in the Northwest Territories and Yukon North Slope are stated in the Arctic Fisheries Principles (DFO 1988c), the Arctic Marine Conservation Strategy (DFO 1987b), and the discussion paper "The Ice Goes Out: The Conservation and Management of the Fish and Marine Mammal Resources of the Northwest Territories and North Slope of the Yukon Territory" (DFO 1988b).

The proposed objective in managing the fish resources of the Northwest Territories and Yukon North Slope is:

> "To conserve Arctic fish and marine mammal resources, enhance the net value of the economic and social benefits received by Canadians from these resources, and provide for the equitable distribution of benefits" (DFO 1988b).

Nine strategies have been identified in a proactive approach to managing fish resources to generate a wide range of benefits for Canadians. Co-operative fishery management is being addressed through native/government resource management boards established through implementation of comprehensive land claims agreements. Management boards provide resource users with a forum for direct involvement in all aspects of fishery management, including the responsibility to recommend resource allocations. Management plans, developed co-operatively by management boards and DFO, will underpin all fisheries management activity.

DFO economics services are being provided to support implementation of the strategies of predicting and measuring results of management actions, planning for fishery management, and co-ordinating fishery development programs.

This report has been prepared to provide resource managers and management boards with a systematic approach for the economic analysis of the fisheries. The report is organized to address three main objectives:

- Section 2 describes fishery and habitat management issues for which economic analysis can usefully be applied;
- Section 3 elaborates on the economic planning concepts and economic planning framework presented in "The Ice Goes Out" discussion paper;
- Section 4 provides indicators and analysis tools for the economic analysis of domestic, commercial, and recreational fisheries.

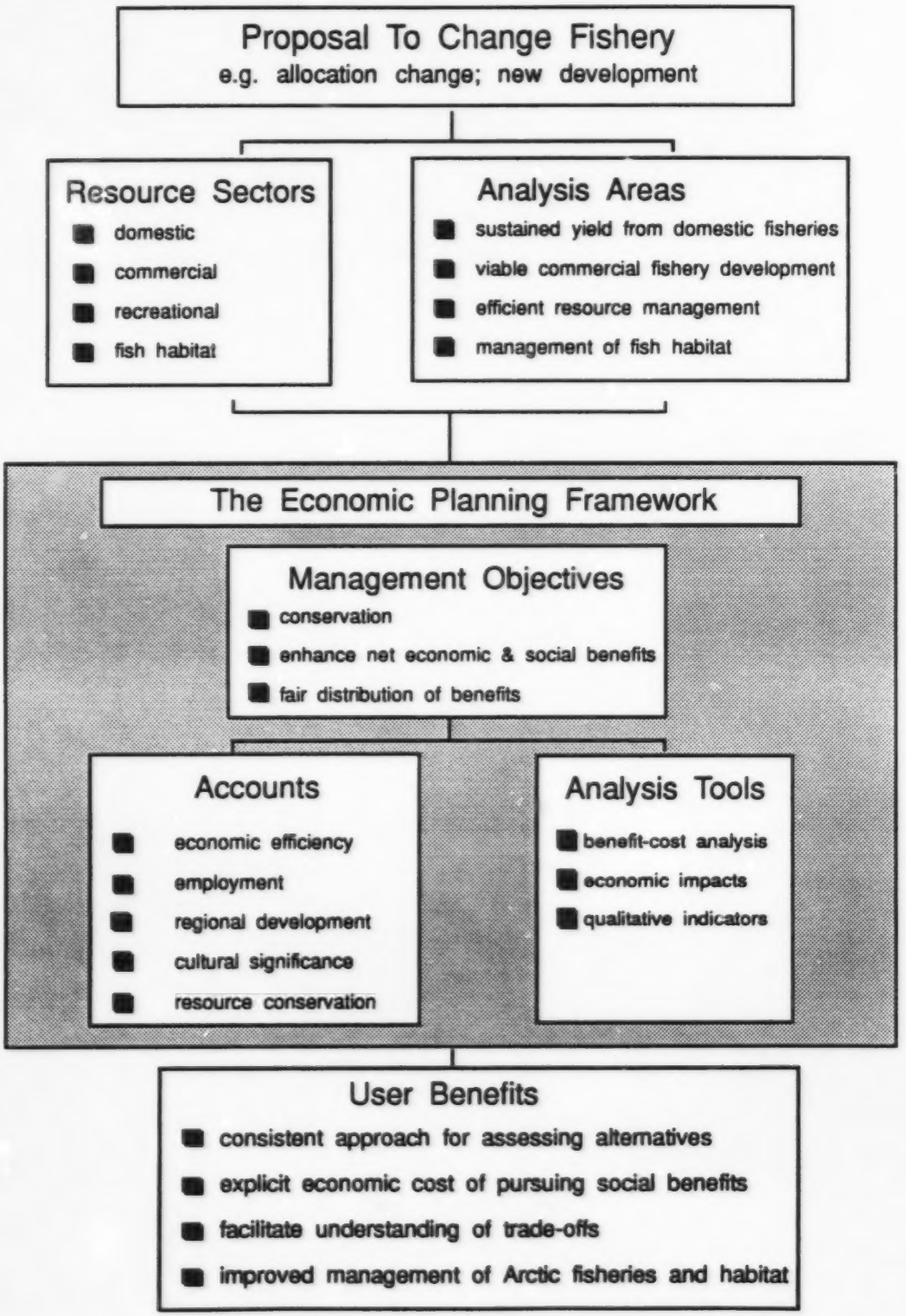
1.1 The Fishery Management Objective

There are three components to DFO's fishery management objective as stated in "The Ice Goes Out" (DFO 1988b): conservation, use of Arctic fish resources to enhance the contribution to economic and social well being, and the equitable distribution of benefits among Canadians.

Conservation means the maintenance of the fish resource, so that it may continue to provide benefits to Canadians. It does not simply mean preservation. Conservation measures are required since fish resources can be reduced by over-harvesting or by damage to fish habitat. Accordingly, DFO proposes to regulate the level of harvesting within the productive capacity of the fish resource. DFO also proposes to protect the habitat upon which the fish resource depends, unless it is assured that benefits will accrue to Canadians that will offset the loss in fish production capacity.

The habitat management objective is to be made operational by ensuring that total fish production capacity will not be diminished as a result of industrial and other activities. Where the loss of natural productivity is allowed, artificial enhancement may be required. This principle is expressed in DFO's Policy for the Management of Fish Habitat (DFO 1986) as "no net loss".

Fig. 1. Overview of the economic planning framework.



Enhancement of net economic and social benefits is the criterion proposed to guide decisions on the allocation of Arctic fish resources. The goal is to realize the economic and social potential of the fishery.

From a public policy perspective, management actions and options that improve economic efficiency are generally better than those which simply transfer economic activity from one location to another, because improved efficiency expands the output potential of the economy as a whole.

Economic efficiency is not the only consideration, since the choice may be to forgo efficiency in the interest of achieving social benefits. DFO proposes the following social objectives be explicitly addressed in the management of the Arctic fishery: the maintenance of distinctive cultures and lifestyles, the reduction of structural unemployment, and the development of local and regional economies.

The equitable or fair distribution of benefits, the final component of the objective, addresses who benefits from the fishery. The importance of distributional issues in the Arctic fishery is evidenced by the requirement to consider rights and obligations arising from: land claim settlements; prior use of the resource, and; the needs of those who live adjacent to fish resources.

"The Ice Goes Out" (DFO 1988b) acknowledged that the resource conservation, economic and social components of the fish and habitat management objective can be complementary or at conflict with each other and with other government activities. Conflicting objectives are at the heart of many fishery management issues, so there is a need for decisions on trade-offs to be made between rival purposes. These decisions are difficult, because the various economic and social benefits are not directly comparable.

Economic analysis strives to place a common measurement for the outputs of various activities in terms of their monetary value, as a measure of individual preferences and utility received. Other classes of benefits, such as the cultural and social significance of the domestic fishery, can be described in qualitative terms, but are not amenable to quantification in monetary terms. Consequently, there is no ready answer as to how differing economic and social benefits can be weighted. Trade-offs between different uses and benefits become a matter of judgement.

"The Ice Goes Out" (DFO 1988b) proposed that the economic and social components of the objective should be evaluated through the use of a multi-account planning framework. The planning framework would be used on a case-by-case basis to display predicted economic and social benefits. The display would assist fishery managers and management boards in the evaluation and ranking of management alternatives.

The cost of achieving social benefits would be estimated by the economic efficiency benefits foregone from the management alternative with the largest net economic benefit. Such an evaluation would assist in the determination of whether social benefits gained are worth more, less, or the same as the economic efficiency benefits lost.

2 Economic Analysis for Fishery Management

Four general subject areas that economic analysis can usefully be applied to support Arctic fish and habitat management decisions are discussed below: sustaining the yield from domestic fisheries; fostering viable commercial fishery development; fostering efficient resource management and; maintaining habitat productivity.

2.1 Sustained Yield from Domestic Fisheries

Economic analysis can be used to approximate the market value of domestic product and harvesting activity, mindful of the methodological difficulties (see 4.1 Domestic fishery). It can be used in the evaluation of the potential gains and losses in allocating resources from domestic to commercial fishery use, or to other in-

dustrial activities.

The wealth provided by the domestic fishery is important to the economic base, local self-sufficiency, and culture of many Arctic communities. Accordingly, DFO's Arctic Fisheries Principles (DFO 1988c) identify that the first priority is to allocate to native subsistence use, subject to the requirements of conservation.

A fundamental concern is to protect the domestic fishery from risk, whenever this fishery is important to a community. A conservative approach seems best in considering developments that may adversely affect the domestic fishery. Risk aversion is warranted because of the slow rate of stock recovery that characterize northern resources, concern for loss of domestic food source, and the negative effect of change on an established culture. It makes sense that risk should be accepted only when it is well understood, and measures have been taken to minimize its occurrence and to redress negative outcomes should they occur. Mishan (1976) provides an overview of quantitative methods for dealing with uncertainty and making decisions in conditions of uncertainty. One method uses the subjective assignment of probabilities to several possible values to determine the distribution of possible outcomes.

An economic criterion, termed the Kaldor-Hicks test after the two economists associated with its initial conception, is typically used in the evaluation of efficiency gains and losses. It states that a proposal is efficient if the gains exceed the losses, so that the gainers could (in principle) compensate the losers and still be better off than the initial position.

The hypothetical nature of compensation implied by the Kaldor-Hicks test has limited appeal for a risk minimizing approach to management of the domestic fishery. Domestic resource users often bear the downside risks of northern resource development, so it may be more appropriate to determine whether those who make development decisions share in the downside risks to the same or greater extent than they share in the upside risks. This is not a pre-condition, but it may influence the acceptability of projects that potentially impact on the sustained yield from the domestic fishery.

2.2 Viable Commercial Fishery Development

Economic analysis can assist fishery managers to achieve forms and levels of community development that might sustain itself, without damaging resources beyond either a biologically sustainable level or a socially acceptable level, whichever is more stringent.

Commercial viability analysis can be used to prepare estimates of needed markets, costs, break-even points, rate of return, risks, and the economic values and impacts of a proposed development.

Viability analysis can also be used to examine the requirement for subsidies. Arctic fishery development has required the infusion of transfer payments (capital and operating subsidies) to supplement market revenues, and this requirement will continue for the foreseeable future.

Analysis of commercial development opportunity should clearly identify the objectives, the limiting factors, and whether or not the critical requirements have or can be met. Limiting factors include supplies of inputs including fish, labour, transport, other raw materials, and the processing and harvesting capital required, as well as start up funds and a market for the products to be produced. It is normally preferable to examine each limiting factor in increasing order of cost of investigation.

The required analysis can be subdivided into four reviews: technical feasibility; biological feasibility; market potential; and commercial viability. The first two reviews are a pre-condition for economic analysis. A technical review is largely an engineering and design question, but is essential to determine whether it is physically possible to do what is proposed.

A biological review is essential to determine if the resource exists in sufficient size to sustain the development envisioned. A pre-condition to development is knowledge of the resource and reasonable certainty with respect to its

carrying capacity or sustained yield. Where the knowledge of the resource is inadequate, a phased program of exploratory fishing supported with biological analysis would be appropriate to avoid, or at least reduce to acceptable levels, the risks and uncertainties associated with capital investment in the fishery.

Market analysis is intended to determine whether a reliable market exists, to estimate the revenues that can be expected, and to assess whether proponents have adequate arrangements to service the targeted market. An estimate of expected revenues is essential for viability analysis. Because market studies are usually much less costly than other forms of analysis, it makes good economic sense to determine if there is a market and what revenues might reasonably be early in the project development. Spending on costlier feasibility and assessment studies, and physical infrastructure, can be undertaken dependent upon the results of the market analysis.

There are, however, some important qualifiers to the standard application of economic analysis. The "dual" nature of the Arctic economy combines the traditional aboriginal economy with a more market-oriented mainstream economy. The value systems of the two are in some respects at conflict. In a market economy, economic value is determined through the workings of the price system and is largely influenced by individual preferences and a given distribution of income. Conservation of common property resources (such as fish) in a market economy is achieved through regulation of the prices or quantities of inputs or outputs.

In contrast, the traditional economy places far more emphasis on communal values and communal decision-making. Usher (1981) describes how many traditional peoples developed, over time, a "customary law" of social and religious practices which serve in fact, if not intent, to conserve essential resources. Values of traditional northern society probably lead to a greater emphasis on sustained utilization and benefits for future generations.

This concern for sustained, future benefits in traditional economies has economic implications. Northern resource users may perceive the benefits and costs of development proposals to be very different than the outcomes suggested by standard project evaluation methods. Significantly different perceptions of benefits and costs arise because the greater value attached to future benefits leads to the selection of a lower discount rate than the opportunity cost measure generally used for project evaluations. In general, the evaluation of benefits and costs can be significantly altered by changes in the discount rate (Mishan 1976).

Where the majority of residents have not participated in a market economy, it requires a "leap of faith" to argue that development can be guided strictly by revealed preferences of individuals in response to organized market forces. At the same time, economic development is being pursued as a commercial venture undertaken to create local employment and income. Conventional economic and financial analyses are required for this purpose. It seems unreasonable, on one hand to argue for economic development in terms of potential economic benefits, and on the other hand to dismiss standard economic analysis. It is reasonable to caution that care must be taken in the application of standard economic analysis in a social structure that maintains strong links to traditional activity.

2.3 Efficient Resource Management

Fishery managers seek to ensure they are systematic and efficient when they plan and conduct programs for management, enhancement, and protection of fish resources; for the administration of fisheries policy, and; for consultation and communication with clients.

Economic analysis can assist fishery managers achieve this administrative goal. It can be used to estimate a maximum level of costs appropriate to manage an activity without incurring net losses to society. It can also be used to examine alternative economic structures that may help resource users and resource managers better meet their objectives, e.g. limited entry schemes for the commercial

fishery.

Much of the economic literature on natural resource management addresses the issue of a type of market failure, technically referred to as an economic externality, and the means of correcting for this failure. Gordon (1954), in his pioneering work on fishery economics, integrated biological and economic analysis to assess the market failure that arises with open-access commercial fishery management. That model is described in Appendix 1.

The economic regulation of the commercial fishery can be achieved by affecting the price of the output or the inputs or by regulating the quantity of outputs or inputs (Clark 1979). The price alternatives include a landings tax (output) or an effort tax (input). The quantity alternatives include individual quotas (output) or effort shares (input). These management strategies are described as limited entry programs, because their aim is to reduce the total inputs in the fishery without directly affecting the efficiency of individual units. With the exception of the landings or effort tax, they may also be called exclusive rights management schemes, because the restriction on the amount of inputs is obtained by granting "quasi-property" rights.

Economic models of the recreational fishery highlight the existence of a market failure, as occurs in the commercial fishery. It arises from the catch externality anglers impose on each other as the quality of fishing declines with increased angling effort. Anderson (1980a, b) developed a model of recreational fishing which integrates the economic and biological factors, and which explained the consequences of this market failure on the recreational fishery. That model is described in Appendix 2.

The existence of a market failure suggests the need for economic regulation of the recreational fishery. McConnell and Strand (1981) observed that in the U.S.A. marine fishery managers have made few attempts to regulate recreational fishing, despite its rather large size. A similar situation exists in Canada, and as a result, economic regulation of the recreational fishery is not well developed. Pricing of recreational fishing opportunities can be used to ration resource access, but in general government has chosen not to do this. In two provinces, Quebec and New Brunswick, recreational fishing rights are priced, in some instances at very high fees.

The commercial nature of some recreational fisheries, such as northern remote-access lodges, suggests the potential for regulatory approaches normally reserved for the commercial fishery. Topolniski et al. (1984) recommended the evaluation of a quota system for sport fishing lodges in Saskatchewan. DFO and GNWT-EDT (1985) recommended a licence limitation and pricing system for Great Bear Lake.

Woolley (1984) described the more common situations, in which pricing is not used, perhaps because pricing restrictions are unpopular with anglers, or because they present a number of manageability problems, and categorized them as "non-restrictive" licensing systems.

2.4 Management of Fish Habitat

Economic questions relating to habitat management may require analysis of:

- the cost of habitat maintenance and whether the costs exceed benefits to those relying on the habitat;
- whether the benefits foregone from developments refused in the interest of habitat maintenance are more, less, or the same as the benefits derived from resource use;
- whether developments that threaten habitat can reasonably afford to sustain the costs of habitat maintenance.

An economic approach to habitat management focuses on the design and implementation of economic incentives and an economic structure that correct for the market failure created by "environmental spillovers". Appropriate economic incentives include pollution taxes, the creation of property rights, or the use of subsidies.

An "environmental spillover" is a form of market failure that occurs when uses of habitat affect the productivity of fish and marine mammal resources, and the resulting costs and benefits are not taken into account by the person or group that creates the effects. Acid rain is a classic case of market failure, since in the absence of public regulation, polluters have no economic incentive to curtail their actions to minimize the economic losses of others.

A good working example of an appropriate economic structure in the NWT is the two party negotiating process established under the Government of the Northwest Territories Renewable Resource Compensation Policy. Under the policy, before development can proceed, contingency plans for compensation must be negotiated between communities and developers.

Analysis of these economic questions is in large measure the application of cost-benefit techniques. The analysis is complicated when impacts on fish and marine mammals and their habitats occur, but there is no current or planned use in the foreseeable future. The inclusion of a type of non-consumptive benefit has been proposed for this situation. Weisbrod (1964) introduced the concept of "option demand" to explain the willingness to pay for the continued availability of an asset or service, even though there is no current intention of using the area or facility in question, and the option of use may never be exercised. Krutilla (1967) developed the concept of "existence value", which recognizes that some individuals may derive some utility or satisfaction from the mere knowledge of the existence of the site or facility, even though they are certain they will never demand, in situ, the services it provides. These approaches have been used to argue for the protection of unique environmental assets.

The question relating to cost structures requires consideration of how the inclusion of habitat maintenance costs would affect the break-even point and rate of return for projects. Changes may range from simple adjustments in operation to significant changes in operation or investment, or the curtailing of output from a project. Where changes are significant, there is a need to determine how remedial measures will be financed, privately or publically, immediately, or on a deferred basis. Typically, the choice of options is determined through a process of negotiation between those potentially affected, the proponent and the regulatory agencies.

Economic analyses as described here can contribute to an improved understanding of the potential impacts of habitat disruption. However, as outlined for the domestic fishery above, the critical questions often relate to incomplete information, uncertainty and risk, and the potential for downside risks to be borne largely by resource users and society at large. Accordingly, a conservative approach to habitat management is also warranted. It may best be assured by avoiding risk, or accepting risk only when it is better understood and measures have been taken to minimize its occurrence and to redress negative outcomes should they occur.

Because of the uncertainties, Arctic habitat is managed in accordance with "no net loss", as articulated in "DFO's Policy for the Management of Fish Habitat" (DFO 1986). The policy is designed to ensure that total fish production capacity will not be diminished as a result of industrial and other activities. The objective of increased natural productive capacity of habitat is linked, through higher fish production and catches, to increased benefits to present and future generations of Canadians (DFO 1988a).

The habitat policy also states habitat managers will look at the economic trade-offs concerning the use of habitat for fish production versus activities related to other sectors of the economy. Such trade-offs are to be considered when making compensatory decisions under the "no net loss" principle:

> "The Department will give due consideration to economic benefits and costs associated with development of alternative solutions to achieve no net loss of productive capacity".

The "no net loss" criterion may differ from an economic efficiency criterion, which would only compensate for habitat in kind, if the benefits or other factors warranted that. Differences between the two approaches provide an indication of the economic cost of risk avoidance.

3 Economic Planning Framework

Two economic evaluation criteria are typically proposed for the assessment of fisheries (DFO and GNWT-EDT 1985; Shaffer 1986; DPA 1986):

- economic efficiency, this being the difference between the value of the output generated and the costs of production;
- economic impact, this being a measure of the effects the fishery has on income, employment and other indicators of performance.

This section expands on the concept of economic efficiency, and the values realized if an "efficient" option is selected. The difference between economic efficiency and economic impact is explained. Alternative procedures are identified to incorporate both economic efficiency and economic impact considerations in the evaluation of fishery management alternatives, and the display method is recommended for implementation.

3.1 Economic Efficiency

Economic efficiency analysis compares the value of output and the costs of inputs. Economic values are determined by the maximum amount people are willing to pay for outputs, and economic costs are determined by the amount people must be compensated to provide inputs.

Economic efficiency is achieved when net economic benefits are maximized. If we use the analogy of baking a pie, certain methods will bake a bigger pie, others a smaller pie. Economic efficiency is achieved when the size of the economic pie is as large as possible, given available resources and technology.

The concept is best formally described with the example of a single commodity. The following example of market demand and supply functions illustrates that market prices and outputs lead to maximum economic efficiency, provided there are no externalities or non-market outputs and inputs to consider.

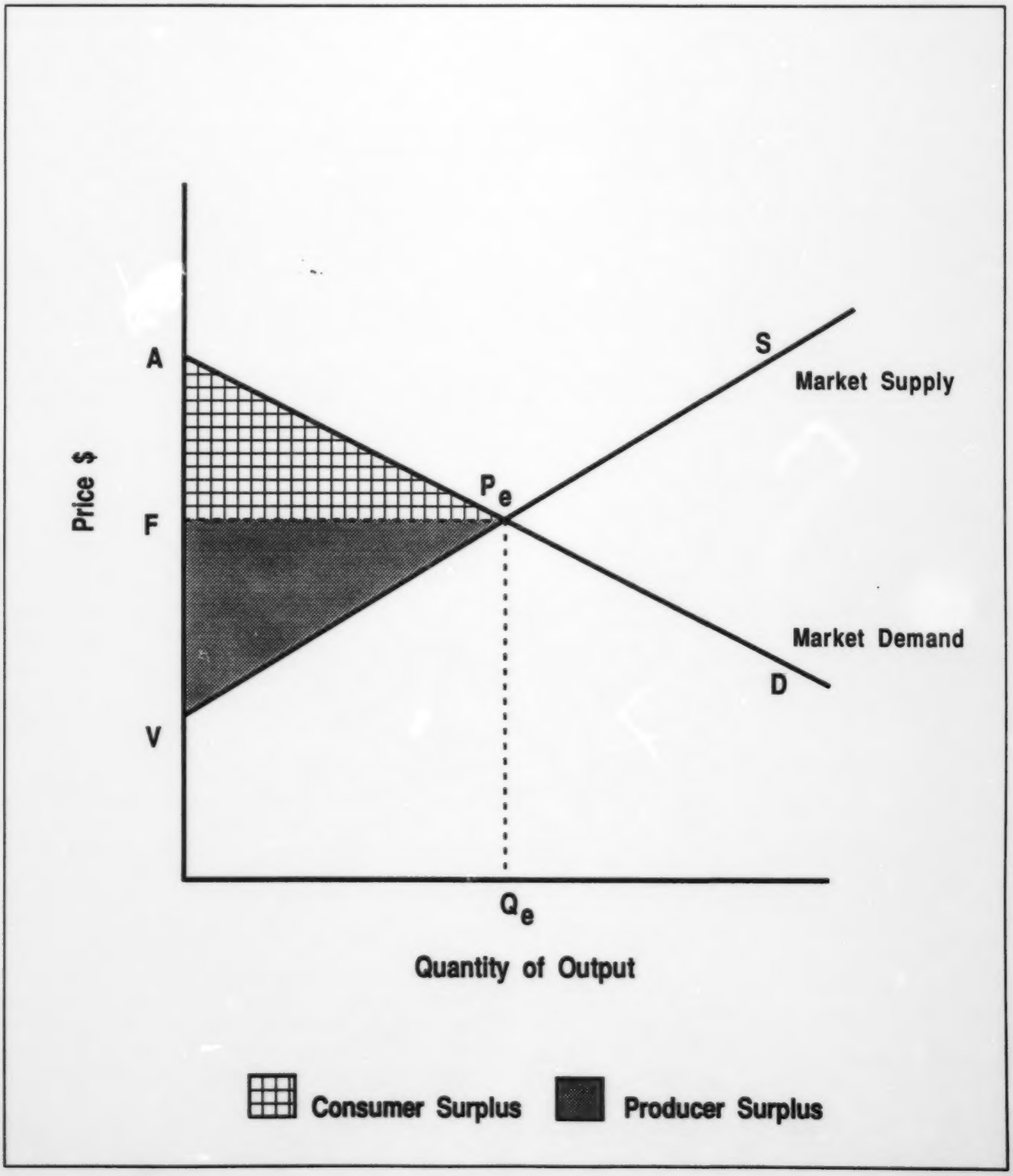
Economic demand is an expression of the amounts of the commodity which consumers are willing to purchase at a series of prices in a given period of time. Demand is clearly distinguished from desires, wants and needs, which are not backed by a willingness and ability to pay. Demand depends on the tastes and preferences of consumers and the prevailing income distribution. The economic relationship between price and quantity is referred to as the law of downward sloping demand and it states that when the price of a good is raised, less of it will be demanded, provided that all other things are held constant. The market demand for a commodity is the sum of all individual demands for all consumers in the market (the curve AD in Fig. 2).

The economic supply curve for a firm relates the quantity supplied to the market price of the commodity, other factors held constant. It is often described as the minimum compensation required by resource owners to produce extra units of the commodity. Market supply is the sum of individual firm supply schedules for all firms in the market. There is a direct relationship between market price and quantity supplied (the curve VS in Fig. 2).

The market demand curve has also been described as a marginal benefit curve, since it indicates the rate of change of total benefit with respect to output. The market supply curve can also be described as a marginal cost curve, since it shows the rate of change of total cost with respect to output.

When marginal benefits (from the demand curve) and marginal costs (from the supply curve) are equated, the difference between to-

Fig. 2. Market demand and supply curves.



tal benefits and total costs is maximized (price OF and quantity OQ_e in Fig. 2). This is an economically efficient level of production, since, if more than the equilibrium quantity is produced, the marginal costs are greater than the marginal benefits and there is a net economic loss to society. On the other hand, if less than the equilibrium quantity is produced, the marginal benefit is greater than marginal cost, so there are gains from increasing the level of production.

When net economic benefits are maximized, society obtains an economic surplus which consists of two parts. Consumer surplus is the excess or surplus of the total amount consumers would have paid for the quantity received above what was actually paid (area AFP_e in Fig. 2). Similarly, producer surplus is the revenue that producers receive over and above that required to cover total costs (area VFP_e in Fig. 2).

The example highlights the economist's fascination with market systems, since in the process of maximizing economic welfare two distinct, but related, purposes are served. On the one hand, a market allocates goods and services between consumers and recoups from them the costs of production. On the other hand, a market guides production and allocates resources into the production of those goods and services for which consumers are willing to pay the most.

There are, however, some fundamental value judgements which underlie such concepts as "economically more efficient". Economic analysis strives to place a common measurement for outputs of various activities in terms of their monetary value. In so doing, it is assumed that actions that contribute to positive increases in well being can be represented by the monetary equivalent of goods and services that society is prepared to relinquish in exchange, while adverse economic effects can also be measured in terms of the monetary equivalent of goods and services that would be needed to compensate for those losses (Hufschmidt et al. 1983).

Economic analysis emphasizes the philosophy of individual consumer sovereignty as the source of relevant economic values, and assumes the degree of satisfaction or level of economic welfare experienced by individuals can be measured in terms of the prices they would be willing to pay for the consumption of goods and services.

The Pareto welfare criterion states that the allocation of resources will be economically efficient when it is impossible to make one individual better off without making some other individual worse off (Millward 1971). In practice, benefit-cost analysis is based on the Kaldor-Hicks test, which suggests a change is economically desirable if, in principle, the gainers can compensate the losers. The criterion in effect states that economic welfare can be measured in monetary terms by adding individual monetary values. It should be clear that value judgements are required to assume that monetary equivalents of welfare can be added and compared and that any resulting change in income distribution is still acceptable (Hufschmidt et al. 1983).

3.2 Economic Impact

Economic impact analysis examines the distribution of benefits among the factors of production (labour, capital, and natural resources). Returning to our analogy of the pie, economic impact analysis is concerned with how the economic pie is shared. It addresses the question For Whom?, in contrast with the economic efficiency questions of What? and How?.

Shaffer (1986) suggested that both economic efficiency and economic impact data warrant consideration in the evaluation of the economic performance of the fisheries. While related, they are not the same. Economic efficiency refers to the net benefits or net economic return generated by the fishery over and above the costs, including the costs of the labour and capital employed. These costs are "opportunity" costs in the sense they represent incomes that could have been realized in the next best alternative. Thus, economic efficiency measures the net increase in the value of output. Economic impact analysis does not consider the opportu-

nity costs of the factors of production, rather it examines the distribution of gross benefits.

Within the framework of the national income and expenditure accounts (Statistics Canada 1975), economic impact methods enable quantification of the wages and salaries, profits and rents which accrue to the fishing industry and their suppliers (the sum of which is the value added), and resulting "multiplier" effects on the economy.

Economic impact analysis has been used to trace the linkages between industrial sectors (e.g. recreational fishermen and their suppliers) and between geographic regions (e.g. northern fish producing regions and southern industrial regions).

Economic impacts are most readily measured using the methods of input-output analysis. Statistics Canada's inter-provincial input-output model of the Canadian economy is useful in documenting employment and income effects over large geographic areas, such as the entire NWT. Such models typically estimate the share of indirect and induced impacts to be very minimal at the territorial level, due to the level of imports from other more developed regions of Canada. For community development plans, there is a need for more specific information than can be provided through the input-output models. Surveys of local income analysis are better suited for this purpose.

3.3 Multi-account Planning

The economic planning framework should enable assessment of management alternatives in terms of their contribution to the broad range of economic and social objectives that impinge on the fishery. Economists advocate economic efficiency as a primary goal for public policy, but typically there are other, rival policy considerations. For the fishery, a good example of competing goals is the choice between an economically efficient option and another option that provides a lower economic yield, but creates more employment activity. Hufschmidt et al. (1983) observed that if conflicts arise between competing goals, there is no special reason why the economic efficiency criterion should predominate.

Even a cursory review of federal and territorial programs shows that Canadian society has, in important ways, sacrificed economic efficiency for the sake of political, cultural, and social development goals. DFO (1988b) proposed emphasis be given to equity and distributional goals in the Arctic fishery with respect to: recognition of aboriginal rights and interests, regional development, and prior participation.

The federal government, through the Indian and Inuit Affairs Program of the Department of Indian and Northern Affairs, has stated priority is to be given Indians and Inuit in achieving their culture, social and economic needs and aspirations, and to ensure that Canada's constitutional and statutory obligations to the Indian and Inuit peoples are fulfilled (DFO and GNWT-EDT 1985).

Similarly, the federal government's political and economic policy framework for the north (Indian and Northern Affairs Canada 1988) identified the development of sustainable regional economies as one of four important and inter-related issues that are central to successful political development in the north. The policy framework further identified that, because the major non-renewable resource sectors are in relative decline, tourism and the commercial use of renewable resources could play a greater role in providing jobs for a growing population. Accordingly, the federal government, in cooperation with the territorial governments, funds several programs to expand the local economy through small business, tourism, and resource projects.

Millward (1971) identified three general options for the systematic treatment of the income distribution effects of public investments: the setting of specific policy goals, the derivation of general weighting systems, and the display method.

The first option, the setting of specific policy goals, is a system which is feasible, if rough, quantitative estimates of distributional aims can be made. In a similar vein, Anderson

(1977) suggested setting bounds for the extent to which economic values may be compromised. However, Millward questioned whether goals are specified in a clear form which would allow such quantification, since "hedging by keeping vague seems much more characteristic". For this reason, the approach is only of limited usefulness.

The second option, the derivation of general weighting systems, involves attaching different weights to the benefits which accrue to different groups of society and income categories. Mishan (1981) noted that the particular weighting schemes that have been proposed are of necessity arbitrary and all assume, not surprisingly, diminishing marginal utility of income. Mishan flatly rejected the idea of employing politically determined weights into a benefit-cost analysis. He observed that "by doctoring the method of evaluation so as to accommodate current political predilections, the economic facts are concealed from the public which is then misled into the belief that the proposal has the sanction of pure economic calculation".

The purpose of the third option, the display method, is to describe to decision takers the distribution of the benefits and costs of a project. While Millward felt the display method "appears to be a pitifully modest proposal", he concluded it may be the limit to which practising project analysts are able to go in the near future. He argued the display method "may tell us a lot about income distribution, about decision-takers' concern over these matters, and about the administrative problems involved in incorporating allowances for these matters into project selection criteria".

The display method has, in practice, been the procedure most used for public project planning. Multi-purpose planning frameworks have been successfully used for planning water resource developments in the United States (Water Resource Council 1969) and Canada (Environment Canada 1975). DFO developed a five account planning framework for the evaluation of the Salmonid Enhancement Program (DFO 1977). The five account system was also proposed as the economic evaluation framework of the policy for the management of fish habitat (DFO 1988a) and for Arctic fisheries and habitat management (DFO 1988b). Within this framework, management options are assessed in terms of their contribution to:

- Economic Efficiency
- Employment
- Regional Development
- Cultural Significance
- Resource Conservation

4 Economic Indicators and Analysis Tools

This section describes methods for the economic efficiency analysis of the domestic, commercial, and recreational fisheries. Economic impact analysis is the quantitative method proposed for the assessment of the contribution to employment and regional development. Qualitative indicators are proposed for the assessment of the contribution to cultural significance and resource conservation.

4.1 Domestic Fishery

The information required to calculate the economic efficiency benefits of the domestic fishery includes the gross value of production, the costs of harvesting, and the revenues and costs of management.

Usher (1976) compared three methods to proxy the gross value of production (income in kind) of the domestic fishery:

- Valuation at local exchange value, i.e. what the product is sold for locally, an approach that requires observation of selling prices in the trade of country foods;
- Valuation at alternative market price, i.e. the value when sold commercially, a method used by Statistics Canada (1975)

to estimate income in kind as a component of farm income. Domestic production is a part of total farm output and it is deemed appropriate to count it as such, whether it is sold for cash or consumed in kind;

- Valuation at substitution costs, as developed by Usher (1965, 1971). Usher suggested the guiding principle "should be to substitute those commodities which would be the most likely substitute in view of local preference and economic capabilities. Indeed, the individual might wish to purchase the very item he is not producing."

Generally, the methods can be expected to provide gross value estimates which may differ by orders of magnitude. The substitution cost method, which typically uses imported protein equivalent sources, is expected to produce the largest measure of gross value.

Local exchange value has the most appeal, since it applies the "willingness to pay" concept that is a cornerstone of consumer demand analysis. Local exchange prices are relevant where output has a totally elastic demand or is such a small increment to output that consumers marginal willingness to pay is unaffected by its level. However, when demand is not totally elastic and changes are large, local exchange prices will under-estimate benefits to the extent that consumer surplus is not accounted for. Furthermore, Usher (1976) cautioned that non-economic considerations are operative (price often depends on kinship or friendship between buyer and seller), and for that reason, he concluded local exchange rates are inappropriate.

Local exchange value has had only limited application to date, since in many communities country foods are not widely exchanged on a cash basis. However, country food stores now operate periodically in some NWT communities, such as Iqaluit and Inuvik, and commercial trade in country foods is being funded through regional development incentives to achieve the goal of import substitution. Opportunities for the application of local exchange values will arise, if these development initiatives are successful. As non-economic factors are also much less a concern, local exchange values are recommended where there is active commercial trade in country foods.

The alternative market price estimate is a second preference, provided there is an active commercial fishery for the product being valued. The method, based on the economic concept of opportunity cost, is well established in national income accounting practice.

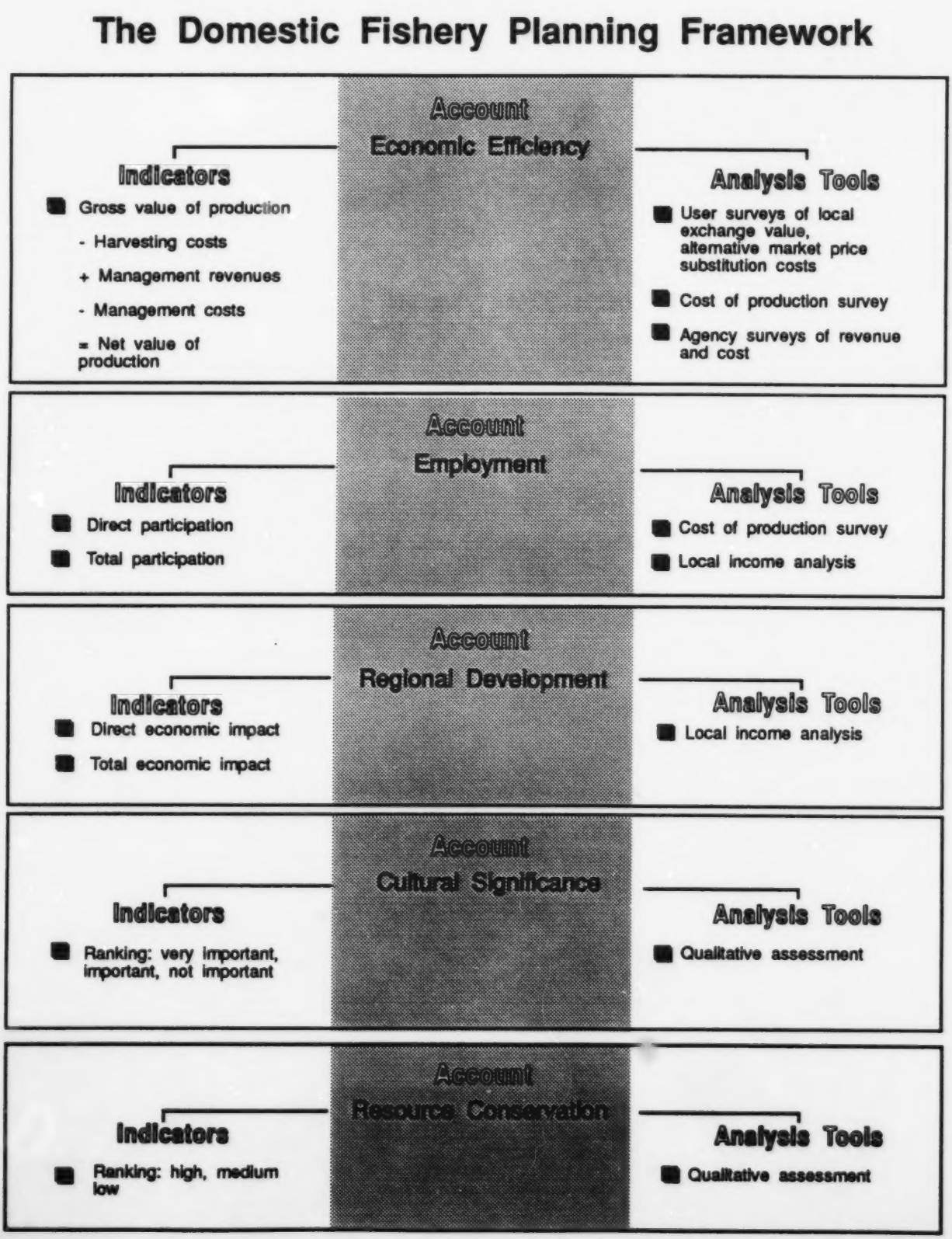
Valuation at substitute cost is recommended where the other methods are not feasible. It has been observed that northerners seem to resist buying country foods when prices reach levels near comparable imported foods (T. Curley, personal communication). Economically, this suggests imported and domestic protein sources are not as close a substitute as is normally assumed. As a result, care must be taken in the selection of the imported goods, prices and quantities, that are used to proxy the value of domestic product.

Clearly, economic valuation of the domestic fishery poses a significant methodological problem. The price system, which provides the grist for the economist's mill, is largely inoperative, yet systems of production, distribution and exchange are well developed. Palmer (1973) observed "the traditional sector and the market sector are two different economic systems" and that "to attempt to find 'the correct' price for these goods is illusory". Nevertheless, he concluded that it is better to approximate these prices and appreciate their limitations than to ignore them entirely.

Estimation of harvesting costs can be done in a cost of production framework (Thompson 1981), for example by inclusion of direct costs, an allowance for capital costs, and the opportunity costs of harvesters' time. While there are a number of questions to be addressed in making this calculation, such as the selection of an appropriate measure of the opportunity cost of labour inputs, or the allocation of joint capital costs to multiple outputs, these issues have been addressed (Usher 1971; DPA 1986).

Management revenues and costs are included

Fig. 3. The domestic fishery planning framework.



in the economic calculation, in order to reflect costs and benefits of the fishery to other Canadians. Their inclusion enables the evaluation of the fishery from the perspective of Canadian society as a whole. Estimation of management revenue and cost may also pose some technical problems, especially in the allocation of joint capital costs.

The net economic value of production of the domestic fishery is defined as the gross value of production, plus management revenues, less harvesting costs, less management costs.

DPA (1988a) applied economic impact methods to the Yukon domestic fishery to estimate direct and total employment and income. One conceptual difficulty in their application is whether domestic fishery activity should be referred to as "participation" or "employment". Participation is proposed for this economic framework, since it is recognized that the activity entails strong components of harvesting, recreation, and cultural expression.

Proposed economic indicators for the significance of the domestic fishery for employment and regional development are: direct and total participation, direct and total economic impact, and duration and extent of participation.

The cultural significance account would be addressed through a qualitative assessment. Typically, this account would be given a very important ranking, consistent with the allocation priority for Arctic fisheries. The proposed indicator for cultural significance is the ranking: very important, important, unimportant.

The resource conservation account for the domestic fishery would also be addressed by way of a qualitative assessment. One important factor to be considered is the status of the stock being harvested and the impact on the stock of the level of domestic harvesting being valued. The proposed indicator for resource conservation is the ranking: high, medium, or low.

Key indicators and analysis tools for the domestic fishery are illustrated in Fig. 3.

4.2 Commercial Fishery

Economic valuation of the commercial fishery examines the relationships between the consumer demand for fish products, the fishing industry costs of harvesting, processing and marketing, and the revenues and costs of managing the fishery (the economic model of the fishery is presented in Appendix 1).

Where a fishery is one of many sources of supply, the market price will not vary as the volume harvested changes. In this situation, the market price of fish represents the value that individuals place on fish products, i.e. their willingness to pay for fish, so the total revenue curve will estimate the gross value of production to society.

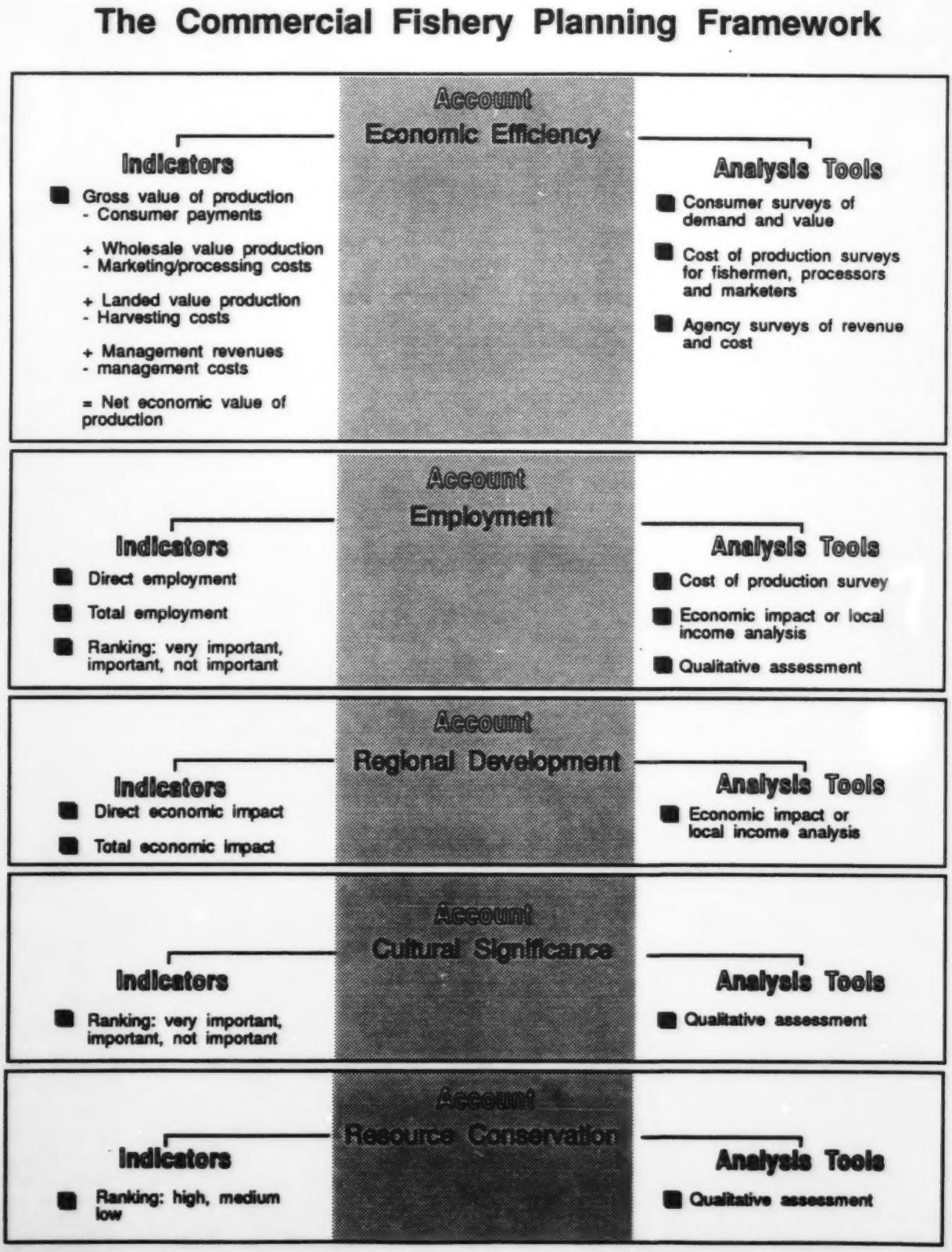
Where the fishery is large in relation to other sources of supply, consumer demand (willingness to pay for fish) will decline as more fish are marketed. In this situation, consumers may derive benefits from purchasing fish at a market clearing price less than their maximum willingness to pay. This benefit is the consumer surplus.

Total costs consist of fishing industry costs (harvesting, processing, and marketing) and fishery management costs. The costs of the fishery measure the value of the resources society uses in the production of fish, where value is determined by the opportunities foregone elsewhere to produce fish and manage the fishery.

As for the domestic fishery, harvesting costs can be calculated within a cost of production framework. The methods have been well established through numerous DFO periodic and special costs and earning surveys for Canadian fisheries conducted as part of DFO's monitoring of the fishery. Examples include Thompson (1981), DFO (1987a), DPA (1988b).

In some fisheries, the opportunity cost of labour may differ from the wages earned, and this benefit should be accounted for. Haveman and Krutilla (1968) provided an approach to determine the opportunity cost of labour, through analysis of the probability of drawing a worker of any specified skill from the unemployment pool and the rate of unemployment

Fig. 4. The commercial fishery planning framework.



among that group.

Where markets are competitive, fish processing and marketing costs will equal the value of production at these stages of the industry. While normal profits are earned, no economic rents accrue. However, if fish processors or marketers are able to set prices in a way which extracts some of the economic rent which potentially accrues at the harvesting and consumer levels, there is a need to examine the benefits and costs for each of the harvesting, processing, and marketing sectors.

Management revenues and costs are included in the aggregate analysis of benefits and costs to Canadian society.

The net economic value of production of the commercial fishery is defined to be the gross value of final products, less the amount paid by consumers, plus the wholesale value of products, less the costs of processing, plus the landed value to fishermen, less the costs of harvesting, plus management revenues, less the costs of management.

Economic impact analysis of the fishery, using either input-output methods or local income analysis, can be used to trace the income and employment effects of fishing industry revenue and expense. Proposed indicators are direct and total employment and direct and total economic impact.

Economic impact and employment effects can be quantified at various stages of the economic production process. Total economic impact is the sum of the direct, indirect, and induced economic impacts. Similarly, total employment is the sum of direct, indirect, and induced employment.

Direct economic impact is a measure of the value added of commercial fishing operations and the value added of direct suppliers to the fishery sector, such as vendors of fuel, bait, nets, twine and food. Direct employment is a measure of the employment activity in fishing operations and in those businesses which are direct suppliers to the fishery sector.

Indirect economic impact is a measure of the value added which arises as a result of the purchases by all industries in which production is required to provide the goods and services for direct suppliers to the fishery sector, e.g. inputs to the food and energy producing sectors would be categorized as an indirect input. Indirect employment is a measure of the employment activity in those sectors which are suppliers to the direct suppliers of the fishery sector.

Induced economic impact arises as a consequence of the inclusion of a household income multiplier and the resulting re-spending effects. Incomes that accrue to individuals are allocated to consumption, savings, and taxes. Increased consumption results in an increase in purchases of other goods and services, thereby giving rise to still further production and income. Induced employment is a measure of the employment activity resulting from these respending effects.

Income and employment multipliers are relative measures which provide an indication of the nature and extent of the linkages between an industry and the rest of the economy. For example, the indirect income multiplier is the ratio (direct + indirect income) ÷ direct income. As a second example, the total employment multiplier is the ratio (direct + indirect + induced employment) ÷ direct employment.

The employment ranking would provide a qualitative assessment of the importance of employment in the fishery. It could be determined from the proportion of total annual income participants derive from the fishery and from the alternatives to fishery activity within the geographic area of interest.

The cultural significance ranking would provide a qualitative assessment of the importance of the commercial fishery to the maintenance of traditions and lifestyles. In some cases, a high rank would be assigned, for example where fishermen participate not to earn a livelihood, but to supplement their incomes or subsidize subsistence harvests (Yonge 1988, 1989). More typically, the limited experience with commercial ventures would suggest a low ranking for this account. The ranking of importance would be: very important, important, or not important.

The resource conservation ranking would

provide a qualitative statement of the stock management status of the resources being harvested by the commercial fishery. The proposed qualitative ranking of importance would be: high, medium, or low.

Key indicators and analysis tools for the commercial fishery are illustrated in Fig. 4.

4.3 Recreational Fishery

Economic evaluation of the recreational fishery examines the gross value and expenditures of the angling experience (including licence fees), service sector revenues and costs, and management revenues and costs (the economic model of the fishery is presented in Appendix 2).

The gross value of the angling experience is the maximum price or cost anglers are willing to incur (pay) to go sport fishing (DPA 1986). Anglers' values consist of: the private costs of angling including the licence fee or toll and the amount that anglers would be willing to pay for the right of access over and above what is actually paid. The latter amount is the consumer surplus.

Two techniques used to estimate the demand for the angling experience are the travel cost method and the contingent valuation method. The travel cost method (Hotelling 1949; Clawson 1959; Clawson and Knetsch 1966), and its modern-day variants (Brown and Mendelsohn 1984), estimate demand and value from data on observed economic behavior such as participation or visitation rates. The contingent valuation method (Davis 1963) seeks a measure of willingness to pay from anglers based on the description of hypothetical "gaming" circumstances, such as differing access prices or fishing quality.

Angler expenditures in pursuit of the sport fishing "experience" include travel outlays, accommodation expenses and the purchase of fishing supplies. These expenditures create income and employment in a variety of retail supply services, which in turn stimulate the demand for goods and services at related levels of the economy.

Where service sector markets are competitive, service sector revenues and costs will be equal. While normal profits are earned, no economic rents accrue at these stages of the industry. However, if for example, fishing lodges set prices in a way which extracts some of the economic rent which potentially accrues to anglers, there is a need to examine revenues and costs of the sector. In addition, where the opportunity cost of labour differs from the wages actually paid this benefit should be accounted for, e.g. where previously unemployed northerners gain employment as guides or outfitters. Angler expenditures will normally represent the principal revenues for the service sector businesses under study, but a complete evaluation sometimes requires that other sources of revenues be considered.

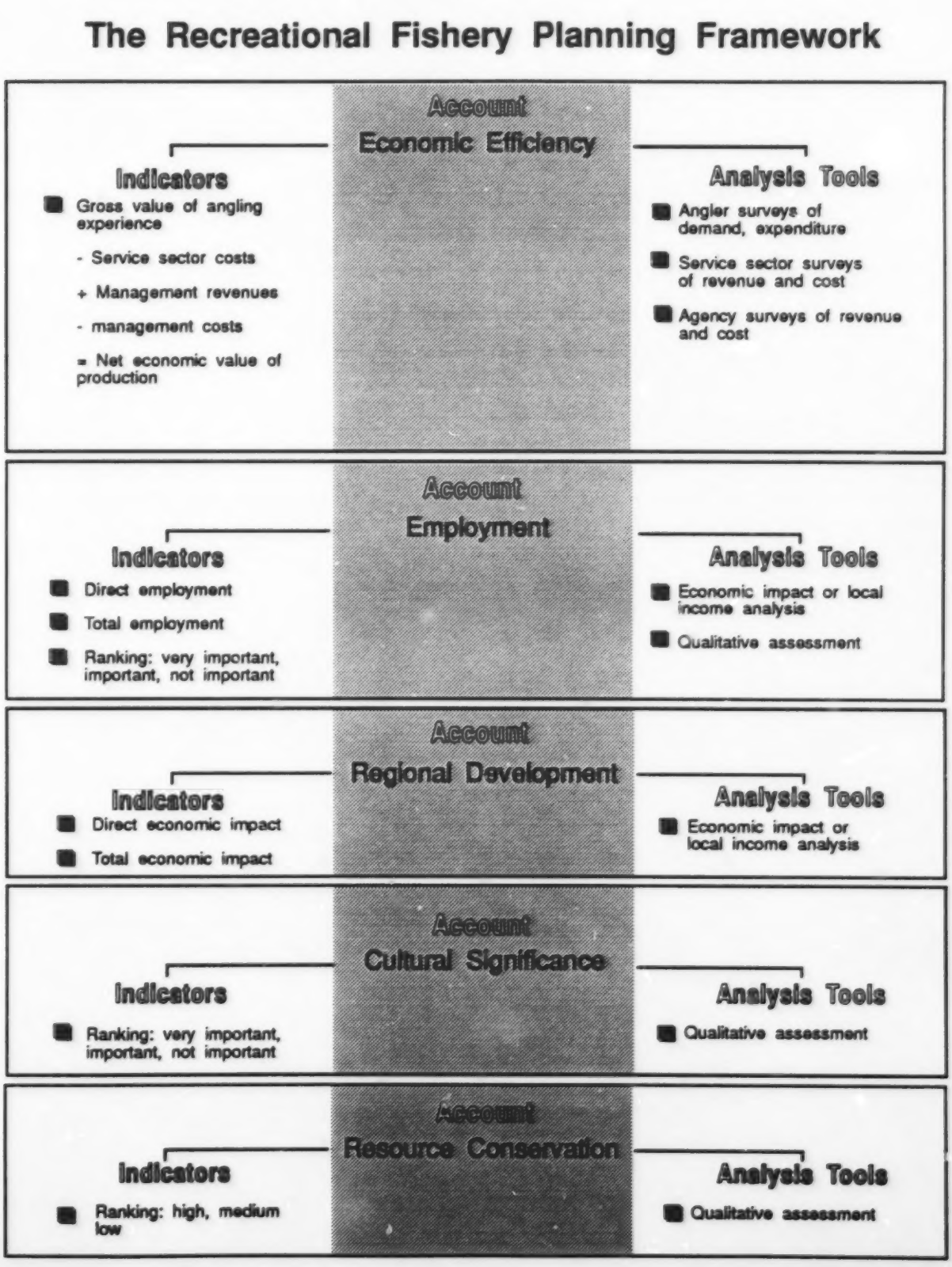
The management revenues and costs are included in the analysis of societal costs and benefits, an approach consistently applied to all fishery sectors.

The net economic value of production of the recreational fishery is defined to be the gross value to anglers, less costs of angling, plus service sector revenues, less service sector costs, plus management income, less management costs.

The economic impacts of the recreational fishery have been the focus of much attention, given the emphasis on use of the fishery to achieve tourism based economic development. Economic impacts of the recreational fishery arise from angler expenditures made in pursuit of the sport fishing "experience". Typically, these trip costs include travel outlays, accommodation expenses, and the purchase of fishing supplies. These expenditures create income and employment in a variety of retail supply services, which in turn stimulates the demand for goods and services at related levels of the economy.

The information required to estimate the regional income impacts of the recreational fishery are derived from data on expenditures by resident and non-resident anglers (Topolniski et al. 1984). That information, properly categorized for use in an input-output model, can be used to calculate direct and total economic

Fig. 5. The recreational fishery planning framework.



provide a qualitative statement of the stock management status of the resources being harvested by the commercial fishery. The proposed qualitative ranking of importance would be: high, medium, or low.

Key indicators and analysis tools for the commercial fishery are illustrated in Fig. 4.

4.3 Recreational Fishery

Economic evaluation of the recreational fishery examines the gross value and expenditures of the angling experience (including licence fees), service sector revenues and costs, and management revenues and costs (the economic model of the fishery is presented in Appendix 2).

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The management revenues and costs are included in the analysis of societal costs and benefits, an approach consistently applied to all fishery sectors.

The net economic value of production of the recreational fishery is defined to be the gross value to anglers, less costs of angling, plus service sector revenues, less service sector costs, plus management income, less management costs.

The economic impacts of the recreational fishery have been the focus of much attention, given the emphasis on use of the fishery to achieve tourism based economic development. Economic impacts of the recreational fishery arise from angler expenditures made in pursuit of the sport fishing "experience". Typically, these trip costs include travel outlays, accommodation expenses, and the purchase of fishing supplies. These expenditures create income and employment in a variety of retail supply services, which in turn stimulates the demand for goods and services at related levels of the economy.

The information required to estimate the regional income impacts of the recreational fishery are derived from data on expenditures by resident and non-resident anglers (Topolniski et al. 1984). That information, properly categorized for use in an input-output model, can be used to calculate direct and total economic

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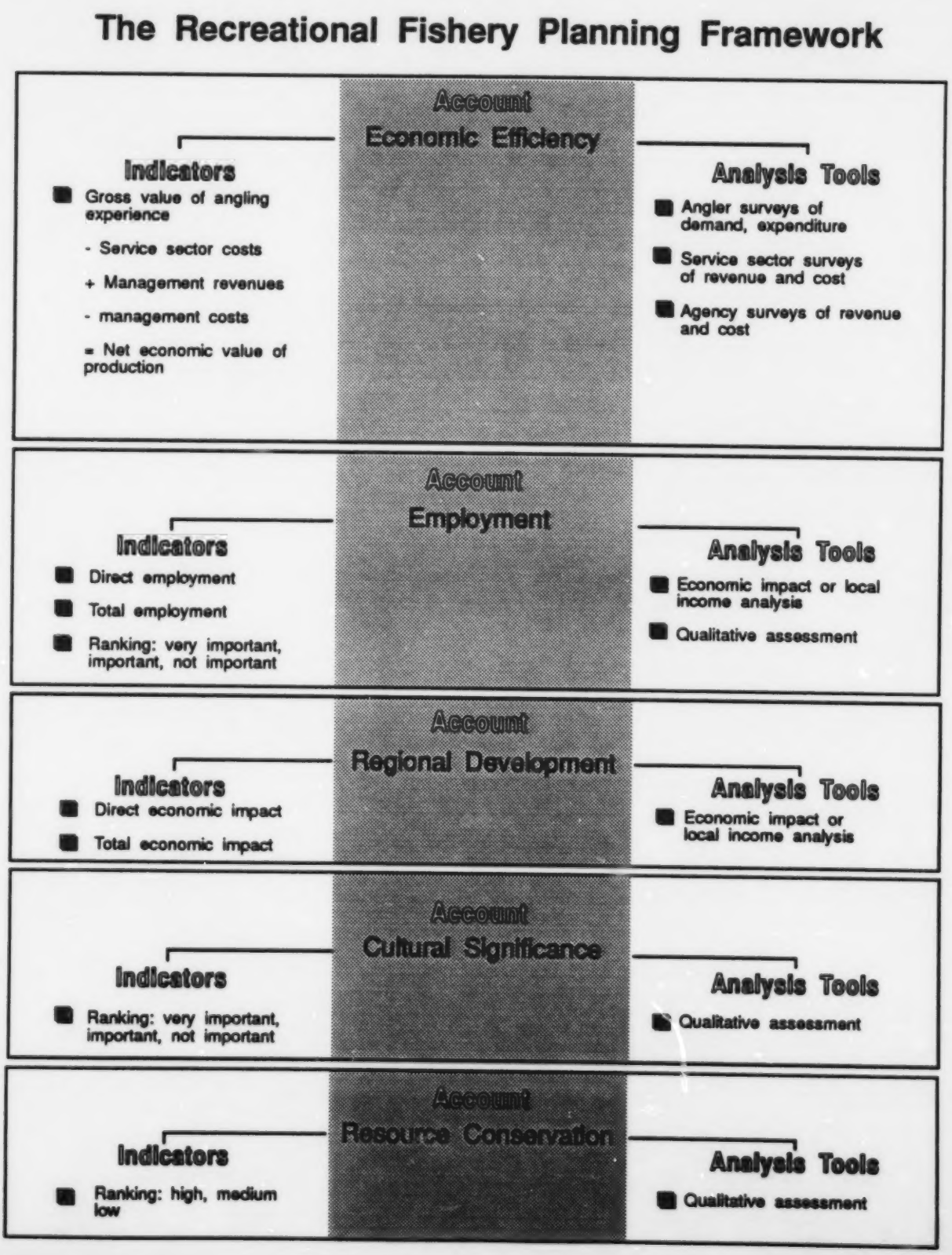

impact and direct and total employment effects over large geographic regions. As noted above, special surveys of local income analysis may be required to provide these measures for community development planning.

The employment account would also include a qualitative assessment of the importance of fishery employment to total economic activity in the area of study. An employment ranking of importance would result.

The cultural significance account would be examined through a qualitative assessment of the importance of the sector to the maintenance of cultural traditions. Typically, given the limited involvement of northern residents in commercial ventures, the cultural significance ranking would be assigned a low ranking.

The resource conservation ranking would also be qualitative, with a statement of the stock management status of the resources being harvested by the recreational fishery. For example, trophy fisheries would be assigned a high rank in this account, since they have a small impact on the natural population structure, reduce the risk of population collapse and retain options for more intensive fisheries.

Key indicators and analysis tools for the recreational fishery are illustrated in Fig. 5.

4.4 Fish Habitat Management

The economic analysis requirement is to establish the change in economic and social benefits resulting from changes in biological productivity due to habitat alteration (e.g. the economic and social consequences of a 10% reduction in fish production due to loss of habitat).

The key indicators for the evaluation of the domestic, commercial, and recreational fisheries were described above. These indicators are applicable for the economic analysis of fish habitat management decisions.

In principle, this change in economic value is determined through a comparison of the fishery "with and without" the habitat alteration. For example, for the commercial fishery, the marginal loss would be measured as the reduction in net returns to the labour, capital, and fish resource employed in the fishery.

The "with and without criterion" is a standard and straightforward economic concept. Unfortunately, it can be complicated in its application. Economic valuation is feasible provided there is an adequate understanding of the physical and biological processes which underlie the changes in fish production.

5 Implementation

The planning framework has been prepared to promote a consistent approach to economic analysis and economic planning for Arctic fishery and habitat management.

DFO is supporting implementation of the framework and the methods described in this report through the conduct of selected case studies, surveys and economic analysis projects. At present, DFO, Central and Arctic Region has provided support for implementation by:

- conducting DFO's first-ever cost and earnings survey of small-scale commercial fisheries in the Canadian Arctic. Results of this survey will provide an important building block for an economic information base on Arctic fisheries;
- initiating a financial and economic modelling project of the nascent Baffin Island inshore marine fishery. Results of this work will support future fishery management and development activities;
- planning a case study of a multiple use anadromous fishery to demonstrate application of the economic framework for resource allocation decisions.

In the future, similar projects may be undertaken and economic research sponsored to support method development and to make operational the economic approaches presented in this report.

Progress may also be achieved through economic services provided in support of other DFO Arctic fishery and habitat management

initiatives. Economic activities linked to the implementation of the planning framework include advice on fishery development, analysis for stock management status reports, and services to improve the quantity and quality of regional harvest statistics.

Significant implementation progress will be dependent on priorities and economic requirements for fishery management plans. Priorities will be set in consultation with resource users, fishery management boards and advisory groups, and other federal and territorial agencies involved in aspects of fishery management and development. Progress will very much be dependent on close co-operation and partnerships with resource users and other agencies. Resource users, through wildlife management boards, have the lead role in resource allocation decisions. Other federal and territorial agencies have the lead role in fishery development.

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Appendix 1. Economic model of commercial fishing.

Gordon's pioneering 1954 study integrated the revenues and costs of commercial fishing with the biological relationship between catch and fishing effort. Fishing effort is a measure of the number of boats, gear, crew size, time spent fishing, etc. applied to the stock or stocks that constitute the fishery. Biology shows that as fishing effort increases, landings increase but at a decreasing rate. A maximum catch will be reached, after which there will be a decline in landings even though additional effort is expended.

In the simplest case, where the fishery is one of many sources of supply, the market price of fish represents the value that individuals place on fish products and the total revenue curve estimates the gross value of production to society. Since the market price will not vary as the volume of catch changes, the total revenue curve will have the same shape as the catch and effort curve (Fig. A1.1).

The total cost curve measures the relationship between the costs of production and the level of output. In the simplest case, industry and fishery management cost curves are linear, so that extra harvesting and fishery management efforts can be applied to the fishery at constant additional cost.

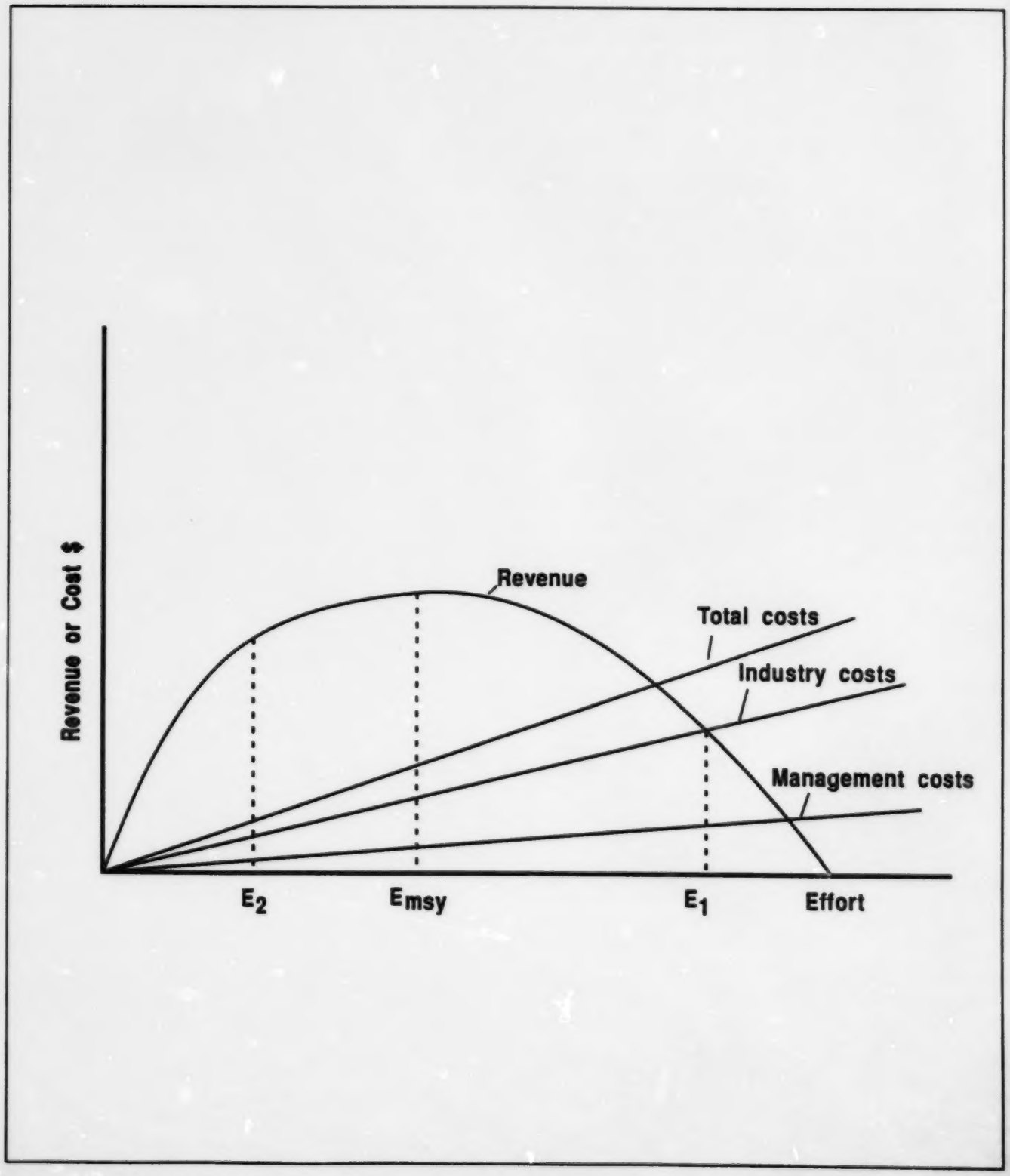
Gordon demonstrated that if entry is not regulated, then the fishery will expand until industry revenues equal industry costs (output E_1 in Fig. A1.1). At any level of effort less than E_1, total and average revenue will be greater than total (average) cost, so that any one individual will find it profitable to enter the fishery. Beyond the level E_{msy}, private revenues are greater than costs, even though total revenue for the fishery as a whole is declining. Beyond E_1, total revenue will be less than total cost and fishermen will leave the fishery. The point where industry revenues equal industry costs is the open-access equilibrium.

The economic efficiency goal of commercial fishery management is to maximize the difference between sustainable revenues from the fishery and the total cost of the fishery (output E_2 in Fig. A1.1). This is the economically efficient level of effort, since with less effort the value to society of additional fish is greater than the services foregone; with greater effort, the value to society of additional fish is less than the cost incurred.

It is also the level of effort where the maximum sustainable economic rent is obtained. Economic rent is the surplus of revenue received over and above what is needed to pay all costs, including a normal return to labour inputs, normal profit on the capital invested in fishing operations, and the public sector costs of management. The economic rent is the value of the fish when used in the commercial fishery.

Subsequent to the Gordon study, Scott (1955) examined the objectives of sole ownership of the fishery. Crutchfield (1962) distinguished between potential and actual economic yields in the valuation of the fishery. Copes (1972), Dow et al. (1975) and Rothschild et al. (1977) extended the analysis to incorporate the objective of social surplus maximization through the consideration of producers and consumers surpluses as well as resource rent. There has more recently been emphasis on dynamic as opposed to comparative static analysis of the fishery (Anderson 1977).

Fig. A1.1. Economic model of commercial fishing.



Appendix 2. Economic model of recreational fishing.

Anderson (1980a, 1980b) developed a model of recreational fishing incorporating the economic factors which influence the demand for recreational fishing with the biological relationship between catch and angling effort.

Biology shows total sustainable yield will increase with increases in fishing effort (e.g. angler-days) until a maximum sustainable yield is reached, but decline as angling effort expands beyond that point (Fig. A2.1). The average sustainable yield, which measures the average catch per angler-day, varies inversely with fishing effort.

The demand for recreational fishing measures the relationship between anglers' willingness to pay to go fishing and the number of days fished, all other factors constant. Higher prices result in lower quantities demanded. Factors which influence demand include individual tastes and preferences, incomes, the prices of related goods and services, and the "quality" of the fishery. Quality variables may include such factors as environmental quality, solitude, infrastructure, the presence of valued game fishes, and the size and abundance of game fishes.

Quality variables are especially important to an understanding of the economics of the recreational fishery. They are hypothesized to vary positively with the demand for, and value of, the recreational fishery. If the quality of the fishery improves, anglers will be willing to pay more for each day of fishing. Conversely, if quality declines, angler willingness to pay declines and demand shifts inward, and the economic value of the fishery declines.

For any one fishery there are a "family" of demand curves, the position of each higher curve corresponding to a higher fishing quality. Along each of these curves the fishing quality is constant, so they are called "constant quality" demand curves. Biology indicates that only one point on each of these curves is relevant, since one level of quality is consistent with any given effort. The line joining these feasible points is called the operational demand curve.

The constant quality demand curve which corresponds to the effort and quality actually observed in the fishery can be used to determine the economic value of the fishery. There are two elements to this value, first what anglers actually pay for the right to fish in the form of licence or "access fees" to the fishery. Second, there is the amount that anglers would be willing to pay for the right of access over and above what is actually paid. This amount, the consumer surplus, enters our calculation of recreational fishing values, since recreational fishing opportunity is provided outside a normal market mechanism with only nominal annual fees charged for the right of access.

The net economic value is the difference between the total area under the constant quality demand curve and the management costs of the fishery (Fig. A2.2). It consists of two elements, the consumer surplus and the resource rent, which is the surplus attributable to the fact that nature has provided mankind with the fish free of charge, enabling the owners of the resource to provide fishing opportunities at a cost far below its value to anglers (DFO 1983).

Fig. A2.1. Economic model of recreational fishing.

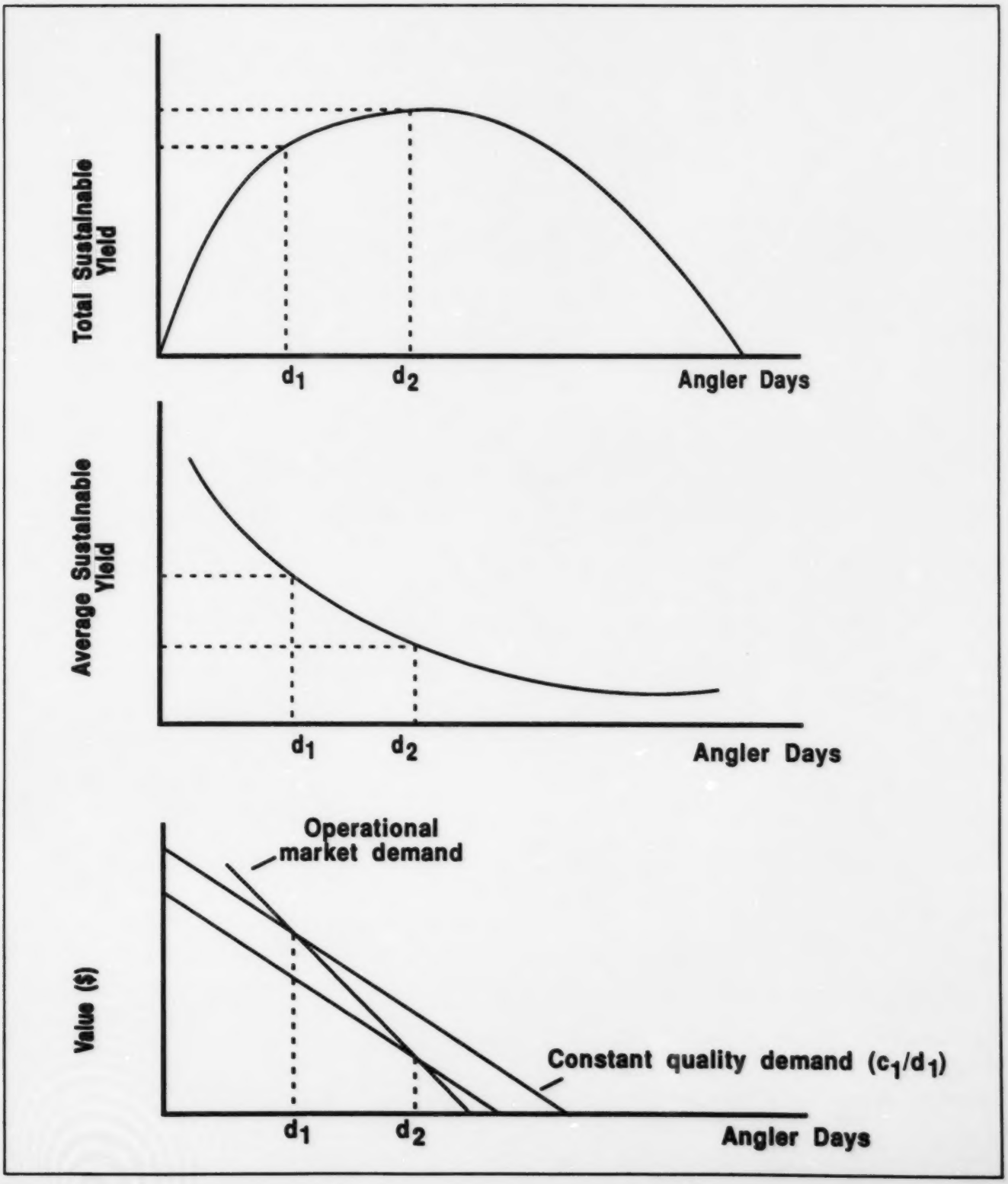


Fig. A2.2. Net economic value of recreational fishing.